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SCIENCE TEACHING PREPARATORY FOR THE HIGH SCHOOL.

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With demands for college entrance becoming more and more exacting in the sciences, with a better appreciation of the value of laboratory science for students who cannot hope to go beyond the high school, and with little opportunity for increase in time allotted the sciences in the high-school courses, teachers of high-school science have seemingly been slow to demand of the grades below the preparatory elementary science teaching needed not only by the children who in so great numbers fail to go on into the high school, but as well to make possible in the high school that quantity and that character of science teaching now demanded there. Teachers of science very generally are agreed in claiming for the sciences a training value, both in the observation work under direction and in the processes of comparison and reasoning based thereupon, not possible in other branches of study; an independence in thinking to conclusions and an exercise of that self-initiative in thought and action demanded of men and women outside the school room and gained in no other school work so well.

There is very general agreement, too, that the "scientific attitude" of mind in the boys and girls entering the high school is too often wanting, that readiness to discern the facts that are presented; that ability to trace the relation of cause and effect and to discriminate between the important and unimportant; that power to state just what is observed rather than preconceived notions of what ought to have been seen. There is wanting an independence in thinking out for one's self from facts in hand the relations of

these facts and their significance; instead, there is too commonly a blind acceptance of the statements of another of what the facts are and what their teaching is. It is not infrequently the case that students come into our classes who for a whole term, perhaps, are almost helpless without a text from which to quote, and who awaken so slowly to a realization that they are capable of seeing each for himself, of thinking each for himself to definite conclusions, of giving expression to thought in form largely or wholly original; they find it so difficult to understand that the text is to supplement and not supplant their efforts both perceptive and apperceptive.

The study of the natural sciences demands in full all the maturity of the average high-school student. To make possible the most and the best science work in the high school demands likewise that in the grades below, from the kindergarten up, there shall have been that continuous course in which are taught those forms and phenomena of nature that are of the everyday experiences of all. From such general science lessons, slowly, perhaps, but surely, should come literally a *leading forth* of the powers of the senses and of the mind—a keenness in observation, an alertness of mind, readiness and independence in thinking, and, withal, that right "attitude" so prized by the science teacher.

It seems strange that science teachers have not long since demanded that before entrance upon high-school work there shall have been through the grades a line of continuous science teaching based upon and an outgrowth of the experiences and experiments of the children and of widely varied character. The choice of topics for such a course is not a question of what particular science shall be taught to the exclusion of any other; it is not that the particular facts taught shall be labeled physics or botany, but that they be of the surroundings of the children and likely to promote an abiding, life-long interest in these surroundings, an interest ever stimulated by the satisfaction coming of fuller comprehension.

There has been a great deal of discussion of how much of this or that science shall be taught in an elementary way, with a very general failure to agree upon anything definite to be required in the grades as science teaching. The fact is too often lost sight of

that the work in the grades is to be nature lessons, and not any particular science or sciences, however elementary; that whatever nature forms or natural phenomena, suited to the children to be taught and directly related to them through daily experiences, are chosen as topics, it is to be a choice regardless of what particular branch of science may be therein represented; the amount and character of the inductive reasoning involved therein, however, count for much.

It is greatly to be regretted that nature study, so-called, should have fallen into such disrepute among science teachers, and more's the pity, with so much reason therefor. It is too commonly the case that all distinction between a study of nature and a study about nature is lost; books telling what someone else has seen and what someone else has thought of the same may be both interesting and instructive, and have a proper place and use, but this is not nature study. To be master of one's surroundings in life, able to use them aright and to one's own best good and general success, requires some measure of ability to note conditions, to see relations, to reach definite conclusions quickly, independently and with few errors of judgment. All this requires of an individual not only some measure of natural aptitude, but, as well, that training which the school may give and give best in the study of nature first hand, day by day, through all the grades to the high school. It is this training and fitness that science teachers in the high schools need in their pupils and must demand if they in turn would meet the demands made upon them.

High-school teachers of science must protest against a mass of so-called nature study, more or less sentimental and worthless, for the sake of their own class and laboratory work, as well as in behalf of long-suffering pupils, and must not be content simply with treating lightly this farcical science teaching, or passing it by with silent contempt. Nature-study readers, the study of poems about nature, stories of animals or of industries, the fairy tales of social converse among birds, beasts, flowers, above all the abominable nature-study "lessons" and "plans" to be found too frequently in the school journals, are one and all to be subjected to the same rigid tests of whether they require of the pupil and secure to him the benefits of a training under direction in the use of the powers

of sense, of mind, of expression. Lessons having as their purpose the cultivation of the æsthetic, of love for animals and plants, an interpretation and appreciation of literary gems or pictures about objects of nature, all are incidental, and whatever their respective merits and whatever their relations to science work in the grades, they are not to be substituted for it any more than for arithmetic. Lessons upon our bodies, their parts, with uses; the preservation of health, with its topics of ventilation, sanitation, choice and preparation of foods, exercise, right habits of life, etc., are to be given, but with little of the anatomy and biology often found in school physiologies. Physiology as a science, if so taught, belongs higher up. So too geography, that many-sided subject, will serve well as a center about which to group and to which to correlate the science lessons. It may well provide the text work to accompany and to be included in the course of science lessons which otherwise are largely oral, partaking in nature of laboratory exercises and prepared both in and out of school.

Two difficulties stand in the way of the realization of such demands by high-school science teachers. One of these is lack in the grades of teachers who themselves have had even the common high-school branches of science properly taught. How absurd the attempt to teach nature study by one who herself neither knows what is to be seen by the children, or its significance if seen! Unable to choose wisely subject matter or to guide aright the children, the only recourse is to feed them instead the husks of dry fact taken from some book, or to employ the time in "talks" with the children whose value as a means toward the development of an intelligent observation of nature and a training for high-school science work is of doubtful value, to say the least. The high schools must give to their graduates, certainly those who are to teach, that knowledge of the sciences rightly acquired, which shall in turn make possible the kind of science teaching desired in the grades. Normal schools can never, because of their short courses, make good any such lack.

Another stumbling block, but fortunately one that high-school teachers can themselves remove, is the need in the grade teaching of such lesson plans, lesson outlines, such selection and arrangement of subject-matter as shall enable the busy teacher, very

largely lacking in facilities for science teaching, to have always in hand the material for the series of science lessons required in her particular grade by the course of study. Simple experiments must be given in detail, together with the successive steps of development of topics, and those directions and suggestions whereby the grade teacher of ordinary ability and limited knowledge of the sciences, working under the usual conditions of the grade schools, may not feel herself compelled by circumstances *to tell the facts* to the children, and drill upon these till the words are memorized, or to make use of a text to the same end. Such teaching has little or none of that training value and development upon which science teachers lay so much stress; the robbery of the children in opportunity and in result is analogous to their loss physical were teachers and textbook writers to kindly relieve them of the task of eating and exercising.

Many a teacher with usable "aids" whereby to get and to keep clearly in mind the spirit and purpose of these nature lessons, so very unlike the usual recitation and class drills, getting once started aright would make the science work in the grades a success even with little knowledge or training herself in the sciences. The book or books to meet this need must yet be written, and high-school science teachers should not be slow in agreeing among themselves upon both the ends to be attained and the means employed in science teaching in the grades.

THE HISTORY OF ZOÖLOGY TEACHING IN THE SECONDARY SCHOOLS OF THE UNITED STATES.*

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[A Contribution from the Department of Biology, Teachers' College, Columbia University.]

(*Concluded from page 209.*)

The division between the second and third periods was marked by the publication of a small book entitled "Practical Zoölogy," by Buel P. Colton, of the Ottawa High School, Illinois. This book was the culmination of those tendencies toward laboratory work which have been noted in the years just preceding. This book is noteworthy in the history of zoölogy not only because it is the culmination of tendencies which have been active through previous history, but because it stands for a method which with modifications is the strongest characteristic of twentieth century teaching and bids fair to continue indefinitely into the future. This book was the first of many laboratory manuals which have since been placed upon the market. The aim, as stated by the author in the preface, was "to aid students in getting a clear idea of the animal kingdom as a whole by the careful study of a few typical animals." Here are found two tendencies which may be traced through Morse and Packard: (1) the study of a few selected animals rather than a heterogeneous perusal of the whole animal kingdom; (2) the slight importance of the starting point in accomplishing the final result. These theories are exemplified in practice by Morse and in theory by Packard. In Colton's book the first definite and successful attempt was made to conduct a systematic study of the whole animal kingdom by means of types. Each animal selected as a representative of a group is fully treated both as to morphology and anatomy. The grasshopper is the first specimen studied and establishes a basis for future work. The order is from the grasshopper, through the arthropods, earthworm and mollusks to the protozoa. The vertebrates are treated in ascending order, and lastly some space is given to the echinoderms, hydra, polyps and sponges. The book

* Essay presented for the degree of Master of Arts, Columbia University, 1901.

consists principally of directions for the study of external anatomy and dissections. It calls for better equipment than had heretofore been required in the pursuit of zoölogy. In addition there are brief accounts of the natural history and development, although these are of very minor importance as compared with structure. Classification is treated in the light of Morse's remark previously quoted, that "there is no use in studying classification until the pupils know something to classify." One point is to be noted in this book which sharply differentiates it from previous works. Almost the first thing observed is the total absence of illustrations. There has been a development in illustrations to correspond with the development of subject matter, and upon the appearance of laboratory manuals they disappear entirely. This is to be accredited to the growing idea that the child is to see for himself, make his own drawings accordingly and form his own conclusions from what he sees. Observation and investigation are now the prevailing principles of work, and consequently all which interferes with their advancement is eliminated. This book, which so completely revolutionized the teaching of zoölogy, held the foremost place among zoölogical text books until the appearance of Boyer's "Elementary Biology" in 1894, when it was partially supplanted, but even today holds a place of some importance.

The old text-book method, however, was not to be done away with suddenly, and in the same year with Colton's book appeared another text book constructed on the plan of many predecessors but with a few improvements. The pupil is to study the text and verify its statements by means of "living animals in menageries and other convenient places." Like all of Steele's books in science this one attained considerable popularity and was widely used for a number of years, but exerted no permanent influence on method in biological teaching. A stronger sentiment was growing that zoölogy was a valuable subject for mind training and general culture and also that the text-book method was inadequate to bring out its full value. In the Report of the Commissioner of Education for 1888-89 is incorporated a portion of an article by David Starr Jordan, then president of Indiana University, taken from the *Popular Science Monthly*. In this

quotation Pres. Jordan says that "the essential of method is to allow nothing to come between the student and the object which he studies." He also clearly states that "the text-book method is of no value."

The Committee of Ten in 1892 reported to the National Educational Association that the minimum of natural history, meaning biology, for high schools should be one year of daily recitation and laboratory work and that it would be better to concentrate the attention throughout the year on either botany or zoölogy rather than to give a half year to each. If zoölogy were chosen the proportion of recitation to laboratory work should be in the ratio of one to three. Packard's suggestion of studying the fish first and making it the basis for comparison in future study was adopted, but after the study of the fish was completed the animal kingdom should be treated in ascending series.

Mr. Boyer in his "Laboratory Manual in Elementary Biology" expanded Mr. Colton's idea and endeavored to meet the demand of those secondary schools which desired to combine the subjects of zoölogy and botany into a continuous one year course, making laboratory work the basis. The book deals with animal and plant morphology and requires of the pupil but little dissection. It is somewhat more extensive than Colton in that it gives in addition to directions for work topics for further study of each type selected and a complete bibliography for study at the end of the book. The arrangement is strictly systematic. The first lesson is on the construction and management of the compound microscope. It is followed by the study of the lowest forms of life, demanding too acute observation for those unskilled in the use of the microscope. Both Colton and Boyer were valuable guides to teachers whose knowledge and experience in biology were limited, because they indicated material and places and times for obtaining it and reference books for the use of both teachers and pupils.

The last five years of this third period of secondary zoölogy teaching were years of great activity and resulting great progress. By 1895 zoölogy had been recognized, at least among schoolmen, as a subject of value and importance in the curriculum. There was tacit agreement that science was one of the three important

lines of work in secondary schools and zoölogy with a history of seventy years was taking its place among other sciences, though the least favored of them all. The question had ceased to be "Shall we teach zoölogy?" or "Why should we teach zoölogy?" but "What method shall be used?" and "At what time in the school course can it be studied most advantageously?" The National Education Association as well as other educational bodies of less influence, was busied with these problems and has continued so to the present day. Three conditions have given botany the preference over zoölogy: (1) the claims of botany to accord with the child's tastes and to adapt itself to the uses of high-school pupils; (2) botany is better suited to general school equipment and preparation of the teacher; (3) college entrance requirements usually include botany rather than zoölogy. When zoölogy is required at all it is usually evident that it is mere book work. This naturally did not improve the character of zoölogy teaching.

In 1895 two new text books appeared and various aspects of the subject were discussed in educational meetings and magazine articles. The conception of biology had broadened so that it was now regarded as a source of education rather than the mere knowledge of plants and animals. The following are the results enumerated by Mr. Alfred J. McClatchie in an article in the March number of the *Popular Science Monthly* for 1895: (1) correct observation; (2) correct expression through (a) drawing, (b) notes, (c) oral discussions; (3) moral development (intellectual honesty); (4) power to generalize; (5) power to reason; (6) scientific imagination; (7) power to discover truth and acquire knowledge; (8) appreciation of the beauties and harmonies of nature; (9) information concerning life and its problems which will be useful in any occupation afterward chosen. Compare for a moment this conception of the possibilities of zoölogy with those held earlier. All previously set forth during seventy years are included in results 1, 2, 4, 5 and 8, and all of these are not enunciated at any one time. In early years 8 was the only one of importance. Gradually 1, 2, 4, and 5 were advanced, and after a time the religious meaning of 8 sank into abeyance. Not until 1895 are all united as integral parts of the real purpose of biology study.

The laboratory method had quite superseded any other method, if not in actual practice, at least in recognition of its superiority as a means of instruction, and attempts were made to approximate its fulfilment when facilities were not offered for its complete development. The text books of the year were Burnet's "School Zoölogy," and Needham's "Elementary Lessons in Zoölogy." The former is a book intended to be used as a basis and guide for class work but by no means to the exclusion of other work. The author urges as necessary to successful results field excursions, collecting, dissection by the class and free use of reference books, of which a list is given at the end of each chapter. The latter is practically a laboratory manual but differs from both Boyer and Colton in that it combines general laboratory directions with descriptions of the habits and development of animals. Both books are illustrated, Burnet's more copiously than Needham's. The latter contains "only such as the pupil cannot make for himself." The illustrations are of various kinds, showing natural history, morphology and anatomical structure in accord with the nature of the text. Both books show a slight reaction against the stern comparative anatomy of the past decade and include a more general study of animals, including physiology, classification and natural history, although this last is but slightly treated.

The study of the psychology of adolescence influenced very considerably the understanding of method in zoölogy as well as giving an impetus to it as a subject supplying the necessary means for developing certain powers.

Among the psychological principles most effective in shaping zoölogical aims was that of habit. Certain habits, mental, moral and physical, which should be of the greatest usefulness could be formed by the study of zoölogy. The means for the cultivation of these habits were found to lie in a combination of laboratory with field and text-book work. The mental habits which can be formed by the study of zoölogy are accurate observation through all the senses, power to distinguish essential from non-essential, careful study of a question before drawing conclusions, reason and judgment. Moral habits may be summed up in the following order: unwillingness to judge without sufficient data, desire

for truth. Physically, laboratory work in biology, as in other sciences, cultivates skill in manipulation. Such a conception made these five years of which we are speaking a time for deep and serious consideration of the best methods of procedure, and keen thought and discussion have brought about various changes, as well as aided in popularizing the subject.

It was becoming more clear to all thinkers on the subject that no one part alone could give a complete idea of the whole, but that anatomy classification, embryology and natural history must all play their part in order that a correct idea might be formed of any one of them. Amongst these broad and liberal views there was a tendency toward the revival of natural history, for so many years superseded by comparative anatomy. Its growth was paralleled by that of other topics but it was destined in a few years to stride ahead of them and again form the basal structure for the study of other aspects. In conjunction with the advance of natural history there grew up also a tendency to confine anatomical study to external features. There were so many other things of importance that time was insufficient to go into detailed study of internal parts and so it was largely omitted. An animal was regarded as an active organism and the first things to be found out about it were the answers to the child's earliest questions, "What is it? and what does it do?"

In the midst of this period of progress, in the year 1897, Kingsley's "Elements of Comparative Zoölogy" was published. This was the extreme of the movement in comparative anatomy which had been in progress for more than thirty years. The movement toward other methods had proceeded too far, however, for the book to meet with great success and it was shortly followed by a book which represented more nearly the spirit of the times. Kingsley's book gives a systematic treatment of the whole animal kingdom, making the fish the basis for comparative work. Vertebrates are first taught in ascending series and then the invertebrate from the complex to the simplest. The book contains laboratory directions for the study of a series of types easily obtainable and gives descriptive accounts of related forms. By combining laboratory guide with a general outline of zoölogy it emphasizes the comparative side. The method of study is in-

ductive. In selecting types the author has considered four things: (1) locality and availability of animals; (2) average ability of students; (3) macroscopic character of the work; (4) consideration of most important facts. The book had an extensive sale for a short time because up to the year 1899 morphology was still the principle subject taught under the title zoölogy. In the January number of *Science* for that year Prof. Conklin wrote "Time was when zoölogy meant merely classification; at present it means little more than morphology." In this same article, however, he notes that the tide is turning more and more to living things.

In the year 1900 there appeared from the press of the Macmillan Company an "Introduction to Zoölogy" by Prof. Davenport, of the University of Chicago, which, we may prophesy, marks the beginning of a fourth period in zoölogy teaching. The book is so complete a departure from anything of recent date that its advent was marked, and it is already running through its fourth edition. This is a bold attempt to restore old-time natural history in a new light, and the twentieth century has yet to prove the success and duration of the movement. Prof. Davenport treats the subject systematically from the natural history side, treating very briefly development, and still more briefly morphology.

During the past year another book has been published which is more representative of the present period than Prof. Davenport's. Kellogg's "Elementary Zoölogy" includes all the various phases of zoölogy, so that the student is enabled to get a broad and comprehensive view of the animal kingdom, learning "something of the functions of animals and something of their life history and habits," and getting "a glimpse of the significance of his particular observations and of their general relation to the animal kingdom as a whole." The author acknowledges in the introduction the value of field, laboratory and recitation work in a course in elementary zoölogy, and urges that each has its place in the course, but says that it is impossible to include directions for all in a text book. The text deals with anatomy, classification, embryology and natural history with laboratory directions for dissection.

A text book in these days, however, does not mean the same thing that it did fifty, twenty-five, or even ten years ago. Instead of being the main dependence as a source of knowledge, it is but one of a number of sources, and not at all the most important one. It is rather for supplementary reading after the subject has been studied as fully as possible from the real object in the laboratory and in the field. There is a continued spread of laboratory and decline of rote instruction, and in this connection a text book is useful only as a reference book unless it be as a laboratory manual. Teachers, as they become better acquainted with their subject, find that a laboratory manual is limited in its adaptations to the conditions under which they are working, and so they are undertaking to make out their own laboratory directions. "The wider use of the inductive investigating spirit is shown in the growing custom of placing new matter before the student in the form of problems so arranged that solution is just within the scope of his own powers." These are the words of Prof. Ganong in the number of *Science* for January 20th, 1899, in relation to botany teaching, and the same is as true of zoölogy as of botany. The number of good reference books in all departments of zoölogy is now so large that better knowledge can be culled from them under wise guidance than one small text book can afford.

The laboratory method itself, which has lived now through upwards of fifteen years, has not come through unchanged. From verification it has passed to investigation. It has become more flexible and more readily adapts itself to varying conditions. The day of laboratory guides is passing, but in its place is coming dynamic work, entailing greater attention to physiology and function.

The last seventy-five years have seen great advance in the teaching of zoölogy. Three lines of improvement have been noted: (1) In aim it has progressed from the narrow ideal of religious and memory training to the broader conception of mental, moral and physical development according to the most recent physiological and psychological researches. (2) Subject matter has broadened through the discoveries of eminent naturalists, as, for example, Darwin, Huxley and many others of less prominence.

Better knowledge has enabled educators to take a more comprehensive survey of the subject and select from the whole the most important parts and arrange them in their proper relations. (3) The method of presentation has passed through three stages, (a) narrative, (b) classification, (c) morphology, and is just now entering upon a new phase which may be called investigation. Although zoölogy dates back to the time of Aristotle, the study of it was entirely neglected during many succeeding centuries, and not until the time of Pestalozzi was it made a part of the school curriculum. Its greatest progress has been during the past twenty-five years, when it has shared with other subjects in the general advance in education. It is at present more active than at any time in its history, and the future gives promise of greater things than the past has seen.

THE PRELIMINARY EDUCATION OF THE ENGINEER.*

BY JOHN PERRY.

When a man has become a great engineer, and he is asked how it happened, what his education has been, how young engineers ought to be trained, as a rule it is a question that he is least able to answer, and yet it is a question that he is most ready to answer. He sees that he benefited greatly by overcoming certain difficulties in his life; and forgetting that every boy will have difficulties enough of his own, forgetting that although a few difficulties may be good for discipline many difficulties may be overwhelming, forgetting also that he himself is a very exceptional man, he insists upon it that those difficulties which were personal to himself ought to be thrown in the path of every boy. It often happens that he is a man who is accustomed to think that early education can only be given through ancient classics. He forgets the dullness, the weariness of his schooldays. Whatever pleasure he had in youth—pleasure mainly due to the fact that the average Anglo-Saxon boy invents infinite ways of escaping school drudgery—he somehow connects with the fact that he had to learn classics.

*From an Address to the Engineering Section of the British Association for the Advancement of Science, delivered by Prof. John Perry, M. E., D.Sc., LL.D., F. R. S., President of the Section, at Belfast, September 11th, 1902.

Being an exceptional boy, he was not altogether stupefied, and did not altogether lose his natural inclination to know something of his own language; and he is in the habit of thinking that he learned English through Latin, and that ancient classics are the best mediums through which an English boy can study anything.† The cleverest men of our time have been brought up on the classics, and so the engineer who cannot even quote correctly a tag from the Latin grammar, who never knew anything of classical literature, insists upon it that a classical education is essential for all men. He forgets the weary hours he spent getting off Euclid, and the relief it was to escape from the class-room not quite stupefied, and he advocates the study of pure mathematics and abstract dynamics as absolutely necessary for the training of the mind of every young engineer. I have known the ordinary abominable system of mathematical study to be advocated by engineers who, because they had passed through it themselves, had really got to loathe all kinds of mathematics higher than that of the grocer or housekeeper. They said that mathematics had trained their minds, but they did not need it in their profession. There is no profession which so much requires a man to have the mathematical tool always ready for use on all sorts of problems, the mathematical habit of thought the one most exercised by him; and yet these men insist upon it that they can get all their calculations done for them by mathematicians paid so much a week. If they really thought about what they were saying, it would be an expression of the greatest contempt for all engineering computation and knowledge. He was pitchforked into works with no knowledge of mathematics, or dynamics, or physics, or chemistry, and, worse still, ignorant of the methods of study which a study of these things would have produced; into works where there was no man whose duty it was to teach an apprentice; and because he, one in a thousand, has been successful, he assures us that this pitchforking process is absolutely necessary for every young engineer. He forgets that the average boy leaves an English school with no power to think

†The very people who talk so much of learning English through Latin neglect in the most curious ways those Platt-Deutsch languages, Dutch and Scandinavian, a knowledge of which is ten times more valuable in the study of what is becoming the speech of the world. And how they do scorn Lowland Scotch!

for himself, with a hatred of books, with less than none of the knowledge which might help him to understand what he sees, and he has learned what is called mathematics in such a fashion that he hates the sight of an algebraic expression all his life after.

I do not want to speak of boys in general. I want only to speak of the boy who may become an engineer, and before speaking of his training I want to mention his essential natural qualification—that he really wishes to become an engineer. I take it to be a rule to which there are no exceptions that no boy ought to enter a profession—or rather, to continue in a profession—if he does not love it. We all know the young man who thinks of engineering things during office hours and never thinks of them outside office hours. We know how his fond mother talks of her son as an engineer who, with a little more family influence and personal favor, and if there was not so much competition in the profession, would do so well. It is true, family influence may perhaps get such a man a better position, but he will never be an engineer. He is not even fit to be a hewer of wood and drawer of water to engineers. Love for his profession keeps a man alive to its interests all his time, although, of course, it does not prevent his taking an interest in all sorts of other things as well; but it is only a professional problem that warms him through with enthusiasm. I think we may assume that there never yet was an engineer worth his salt who was not fond of engineering, and so I shall speak only of the education of the young man who is likely to be fond of engineering.

How are we to detect this fondness in a boy? I think that if the general education of all boys were of the rational kind, which I shall presently describe, there would be no great difficulty; but, as the present academic want of system is likely to continue for some time, it is well to consider things as they are. Mistakes must be made, and the parent who tries during the early years of his offspring to find out by crafty suggestion what line his son is likely to wish to follow will just as probably do evil by commission as the utterly careless parent is likely to do evil by omission. He is like the botanical enthusiast who digs up plants to see how they are getting on. But in my experience the Anglo-

Saxon boy can stand a very great deal of mismanagement without permanent hurt, and it can do no kind of boy any very great harm to try him on engineering for a while. Even R. L. Stephenson, whose father seems to have been very persistent, indeed, in trying to make an engineer of him against his will, does not seem, to a Philistine like myself to have been really hurt as a literary man through his attendance on Fleeming Jenkins' course at Edinburgh —on the contrary, indeed. It may be prejudice, but I have always felt that there is no great public person of whom I have ever read who would not have benefited by the early training which is suitable for an engineer. I am glad to see that Mr. Wells, whose literary fame, great as it is, is still on the increase, distinguishes the salt of the earth, or saviors of society, from the degraded, useless, luxurious, pleasure-loving people doomed to the abyss, by their having had the training of engineers and by their possessing the engineer's methods of thinking.

It may be that there are some boys of great genius to whom all physical science or application of science is hateful. I have been told that this is so, and if so I still think that only gross mismanagement of a youthful nature and have produced such detestation. For such curious persons engineering experience is, of course, quite unsuitable. I call them "curious" because every child's education in very early years is one in the methods of the study of physical science; it is Nature's own method of training, which proceeds successfully until it is interfered with by ignorant teachers who check all power of observation and the natural desire of every boy to find out things for himself. If he asks a question, he is snubbed; if he observes Nature as a loving student, he is said to be lazy and a dunce, and is punished as being neglectful of school work. Unprovided with apparatus, he makes experiments in his own way, and he is said to be destructive and full of mischief. But however much we try to make the wild ass submit to bonds and the unicorn to abide by the crib, however bullied and beaten into the average schoolboy type, I cannot imagine any healthy boy suffering afterwards by part of a course of study suitable for engineers, for all such study must follow Nature's own system of observation and experiment. Well, whether or not a mistake has been

made, I shall assume the boy to be likely to love engineering, and we have to consider how he ought to be prepared for his profession.

I want to say at the outset that I usually care only to speak of the average boy, the boy usually said to be stupid, ninety-five per cent of all boys. Of the boy said to be exceptionally clever I need not speak much. Even if he is pitchforked into works immediately on leaving a bad school, it will not be long before he chooses his own course of study and follows it, whatever course may have been laid down for him by others.

Perhaps I had better state plainly my views as to what general education is best for the average English boy. The public schools of England teach English through Latin, a survival of the time when only special boys were taught at all, and when there was only one language in which people wrote. Now the average boy is also taught Latin, and when he leaves school for the army, or any other pursuit open to average boys, he cannot write a letter, he cannot construct a grammatical sentence, he cannot describe anything he has seen. The public school curriculum is always growing, and it is never subtracted from or rearranged. There is one subject which ordinary schoolmasters can teach well—Latin.* The other usual nine subjects have gradually been added to the curriculum for examination purposes; they are taught in water-tight compartments—or, rather, they are only crammed, and not taught at all. Our school system resembles the ordinary type of old established works, where gradual accretion has produced a higgledy-piggledy set of shops which one looks at with stupefaction, for it is impossible to get business done in them well and promptly, and

*Only one subject—Latin—is really educational in our schools. I do not mean that the average boy reads any Latin author after he leaves school, or knows any Latin at all ten years after he leaves school. I do not mean that his Latin helps him even slightly in learning any modern language, for he is always found to be ludicrously ignorant of French or German, even after an elaborate course of instruction in these languages. I do not mean that his Latin helps him in studying English, for he can hardly write a sentence without error. I do not mean that it makes him fond of literature, for of ancient literature or history he never has any knowledge except that Caesar wrote a book for the third form, and on English literature his mind is a blank. But I do mean that, as the ordinary public-school master is really able to give a boy easy mental exercises through the study of Latin, this subject is in quite a different position from that of the others. If any proof of this statement is wanted, it will be found in the published utterances of all sorts of men—military officers, business

yet it seems impossible to start a reform anywhere. What is wanted is an earthquake or a fire—a good fire—to destroy the whole works and enable the business to be reconstructed on a consistent and simple plan. And for much the same reason our whole public school system ought to be "scrapped." What we want to see is that a boy of fifteen shall be fond of reading, shall be able to compute, and shall have some knowledge of natural science; or, to put it in another way, that he shall have had mental training in the study of his own language, in the experimental study of mathematics, and in the methods of the student of natural science. Such a boy is fit to begin any ordinary profession, and whether he is to enter the church, or take up medicine or surgery, or become a soldier, every boy ought to have this kind of training. When I have advocated this kind of education in the past I have usually been told that I was thinking only of boys who intend to be engineers; that it was a specialized kind of instruction. But this is very untrue. Let me quote from the recommendations of the 1902 Military Education Committee (Report, p. 5):

"The fifth subject which may be considered as an essential part of a sound general education is experimental science; that is to say, the science of physics and chemistry treated experimentally. As a means of mental training, and also viewed as useful knowledge, this may be considered a necessary part of the intellectual equipment of every educated man, and especially so of the officer, whose profession in all its branches is daily becoming more and more dependent on science." When statements of this kind have been made by some of us in the past, nobody has paid much

men, lawyers, men of science, and others—who, confessedly ignorant of "the tongues," get into a state of rapture over their school experiences and the efficiency of Latin as a means of education. All this comes from the fact, which schoolboys are sharp enough to observe, that English schoolmasters can teach Latin well, and they do not take much interest in teaching anything else. It is a power inherited from the Middle Ages, when there really was a simple system of education. I ask for a return to simplicity of system. English (the King's English; I exclude Johnsonese) is probably the richest, the most complex language, the one most worthy of philologic study; English literature is certainly more valuable than any ancient or modern literature of any one other country, yet admiration for it among learned Englishmen is wonderfully mixed with patronage and even contempt. At present, is there one man who can teach English as Latin is taught by nearly every master of every school? Just imagine that English could be so taught by teachers capable of rising to the level of our literature!

attention; but I beg you to observe that the Headmaster of Eton and the Headmaster of St. Paul's School are two of the members of the important committee who signed this recommendation, and it is impossible to ignore it. Last year, for the first time, the president of the Royal Society made a statement of much the same kind, only stronger, in his annual address. I am glad to see that the real value of education in physical science is now appreciated; that mere knowledge of scientific facts is known to be unimportant compared with the production of certain habits of thought and action which the methods of scientific study usually produce.

As to English, the committee say: "They have no hesitation in insisting that a knowledge of English, as tested by composition, together with an acquaintance with the main facts of the history and geography of the British empire, ought in future to hold the *first* place in the examination and to be exacted from all candidates." The italics are mine. It will be noticed that they say nothing about the practical impossibility of obtaining teachers. As to mathematics, the committee say: "It is of almost equal importance that every officer should have a thorough grounding in the elementary part of mathematics. But they think that elementary mechanics and geometrical drawing, which under the name of practical geometry is now often used as an introduction to theoretical instruction, should be added to this part of the examination, so as to ensure that at this stage of instruction the practical application of mathematics may not be left out of sight." As Sir Hugh Evans would have said, "It is a very discretion answer—the meaning is good"; but I would that the committee had condemned abstract mathematics for these army candidates altogether.

This report appears in good time. It would be well if committees would sit and take evidence as to the education of men in the other professions entered by our average boys. It is likely that when an authoritative report is prepared on the want of education of clergymen, for example, exactly the same statements will be made in regard to the general education which ought to precede the technical training; but perhaps a reference may be made in the report to the importance of a study of geology and biology as well as physical science. Think of the clergyman being able to meet his scientific enemies in the gate!

Thanks mainly to the efforts of a British Association Committee, really good teaching of experimental science is now being introduced into all public schools, in spite of most persistent opposition wearing an appearance of friendliness. In consequence, too, of the appointment of a British Association Committee last year, at what might be called the psychological moment, a great reform has already begun in the teaching of mathematics. Even in the regulations for the Oxford Locals for 1903 Euclid is repudiated. It seems probable that at the end of another five years no average boy of fifteen years of age will have been compelled to attempt any abstract reasoning about things of which he knows nothing; he will be versed in experimental mathematics, which he may or may not call mensuration; he will use logarithms, and mere multiplication and division will be a joy to him; he will have a working power with algebra and sines and cosines; he will be able to tackle at once any curious new problem which can be solved by squared paper; and he will have no fear of the symbols of the infinitesimal calculus. When I insist that a boy ought to be able to compute, this is the sort of computation that I mean. Four years hence it will be called "elementary mathematics." Four years ago it was an unorthodox subject called "practical mathematics," but it is establishing itself in every polytechnic and technical college and evening or day science-school in the country. Several times I have been informed that on starting an evening class, when plans have been made for a possible attendance of ten or twenty students, the actual attendance has been 200 or 300. Pupils may come for one or two nights to a class on academic mathematics, but then stay away for ever; a class in practical mathematics maintains its large numbers to the end of the winter.*

Hitherto the average boy has been taught mathematics and mechanics as if he were going to be a Newton or a Laplace; he learned nothing and became stupid. I am sorry to say that the teaching of mechanics and mechanical engineering through experiment is comparatively unknown. Cambridge writers and other

*To many men it will seem absurd that a real working knowledge of what is usually called higher mathematics, accompanied by mental training, can be given to the average boy. In the same way it seemed absurd 500 years ago that power to read and write and cipher could be given to everybody. These general beliefs of ours are very wonderful.

writers of books on experimental mechanics are unfortunately ignorant of engineering. University courses on engineering—with one splendid exception, under Professor Ewing at Cambridge—assume that undergraduates are taught their mechanics as a logical development of one or two axioms; whereas in many technical schools under the Science and Art Department apprentices go through a wonderfully good laboratory course in mechanical engineering. We really want to give only a few fundamental ideas about momentum and the transformations of energy and the properties of materials, and to give them from so many points of view that they become part of a student's mental machinery, so that he uses them continually. Instead of giving a hundred labor-saving rules which must be forgotten, we ought to give the one or two ideas which a man's common sense will enable him to apply to any problem whatsoever and cannot be forgotten. A boy of good mathematical attainments may build on this experimental knowledge afterwards a superstructure more elaborate than Rankine or Kelvin or Maxwell ever dreamed of as being possible. Every boy will build some superstructure of his own.

I must not dwell any longer on the three essential parts of a good general education which lead to the three powers which all boys of fifteen ought to possess; power to use books and to enjoy reading; power to use mathematics and to enjoy its use; power to study Nature sympathetically. English board school boys who go to evening classes in many technical schools after they become apprentices are really obtaining this kind of education. The Scotch Education Board is trying to give it to all boys in primary and secondary schools. It will, I fear, be some time before the sons of well-to-do parents in England have a chance of obtaining it.

PHYSIOLOGY AS A SCIENCE STUDY IN THE HIGH SCHOOL.*

BY GRACE F. ELLIS,

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Physiology was the first of the life sciences to have a place in the curricula of the schools, but in its introduction, and for many years thereafter, it bore little resemblance to a science as we now understand the term. It was a textbook subject, hated by the unhappy teacher to whom it was assigned and avoided by the pupils whenever possible.

At a later day it consisted chiefly of certain dicta concerning the effects of alcohol on the different systems of the human body. It was seldom or never illustrated, for illustration to the lay mind savored of the handling of "inwards," a thing to be religiously avoided.

It is small wonder then that this most important of the sciences has fallen into disrepute among educators themselves, and receives but a scanty and grudging recognition in the assignment of subjects.

In the face of all this I do not feel inclined to modify the statement I have made above, that it is the most important science in the curriculum. To it every other science, properly arranged, should lead; to it, also, the pupil should bring not only the facts of botany, zoölogy, chemistry and physics, but the feeling that here he is to learn how to make the most of himself—the best use of this wonderful machine which holds us each, and through which, and by means of which, we make the world better by our having lived.

The optimum and logical preparation for physiology would be that botany, zoölogy, chemistry and physics should precede it. This might be accomplished by placing it in the last half of the twelfth year. Parenthetically, let me say that we expect to offer such a course after this year, and that physiology is also taught

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in connection with zoölogy during a year's course in the latter subject. It is a part of the zoölogy, not a subject taken up at the end of work on vertebrates, but introduced by the study of foods, when we reached a point in invertebrate work where that could profitably be handled; by a farther study of glands and digestion, when glands and their functions became of interest in the zoölogy and by a study of motor organs (amœboid cells, ciliated cells and muscles), when in worms and molluscs, muscular activity was noticeable.

Study of circulatory systems is made when any animal large enough to have a distinct system for the circulation of blood, is taken up in the laboratory. Respiration and excretion follow naturally.

The study of the nervous system will be taken up in connection with work on vertebrates, beginning with functions of nerves and ganglia when the class finishes the work on arthropoda. The skeleton in this course will be the last thing to be considered, instead of, as usual, the first thing, and in connection with it will be some work on muscles. This work will be illustrated by the use of the "joint apparatus" devised by Dr. Fitz, of Harvard.

This outline is not primarily of physiology, but only of that treatment of the subject which it seems to me ought to be included in any course in zoölogy, unless the zoölogy has been preceded by physiology, or is to be followed by it.

Where physiology is to be studied by itself, the first thing to be considered in outlining the work is where it is to come in the high-school course. I have indicated what I consider its proper place. Others will undoubtedly think differently, but, at any rate, all will agree that if it is not preceded by some chemistry and physics, it must be illustrated by simple experiments in order to make it comprehensible by the student.

The teacher of physiology may talk of oxidation and digestion, of proteids in the food, calcium phosphate in the bones, of carbon dioxide and nitrogen in the air, but unless he and his pupils understand the elements of chemistry, unless they see and handle the things they talk about, they might as well talk of Greek verbs. With the microscope he may show them cells, but he can-

not go further—unless he is a chemist—and show them that the whole complex animal body has been built up of three invisible gases and carbon.

In this I find the starting point for my work; in the laboratory, without any textbook and only a sheet of directions as to processes, and questions as to results, the learner finds out for himself something about the substances which enter into the composition of his own body.

This introductory work is followed by a set of very simple experiments on acids and alkalies, and the whole by a sharp quiz which shall "fix" the results. Then the study of food can be introduced with experiments to show the reactions of various tests for starches, sugars, proteids, fats and minerals. A few foods may be tested to show how many and what food principles they contain, these studies to be followed by a series of experiments on digestion in which test tubes, containing foods and digestive fluids, are suspended in a water bath with a chemical thermometer and kept at a temperature of 99° F.

I like to precede the study of the alimentary canal by a dissection of some mammal, in which peristaltic action, the divisions of the canal, locations and connections of glands are pointed out. Students are sometimes required to make a hasty sketch of the dissection and compare with location of the same parts in the manikin. While the work on foods is going on in the laboratory in the class-room we discuss work and energy, uses of foods, etc., and oxidation and combustion are illustrated.

The alimentary canal and digestion are then studied in detail. The former illustrated by slides to show structure of stomach, intestines, glands, etc., and the latter by experiments on fat-digestion (emulsions and soaps) and absorption. A bit of sausage skin tied over the flaring end of a test tube whose closed end is chipped off will give good results as to absorption of digested and undigested proteids. In food study, as in many other parts of my laboratory work, I am indebted to Peabody's "Laboratory Manual" for suggestions.

We follow digestion with circulation. When it is possible we have in the laboratory three jars of blood, the whipped, coagulated, and fibrin from the first, with a microscopic study of frog's

and human blood. This gives us an impetus; aided by study of circulation in the frog's foot—or, better still, in the tadpole's tail or the caudal fin of a small fish, the interest grows until it is positive excitement when we study the beating heart of a frog or turtle, and dissect the calf's heart from the market.

Let me say in passing that careful counting and timing with a watch will show the comparative length of work and rest periods for the heart.

Difference in arterial and venous currents, pulse, arterial spurting and slowing of blood flow in capillaries are all illustrated in a simple piece of apparatus consisting of glass Y-tubes and rubber tubing, the construction of which is explained in Macy's Physiology.

At the end of this work, along with quiz and laboratory notes, I require each pupil to put on the board or paper his notion of the structure of the heart in a diagram that shall show chambers, valves, blood vessels, etc.

Respiration and excretion are next in order. So essential does the study of lung capacity seem to me that I have devised an apparatus for its measurement, a figure of which was published in School Science, Vol. I., No. 7, p. 372. Accompanying it is an outline of the questions each pupil answers in regard to it. When the work is handed in, a personal talk with each pupil emphasizing the points made is very helpful. Students take pride in a good lung record and often take pains to improve it, taking occasional measurements through the year.

Dissection of kidney and slides of sections through the skin sufficiently illustrate the functions of excretion.

The students do not open their textbooks to study the nervous system until they have made a series of simple experiments on frogs to get an idea of the use of nerves and ganglia. In this work, especially, should care be taken that the learner distinguishes in the experiments the results he observes from the inferences drawn from these results.

If we should study the growth of civilization we should find it had been brought about by the mental operations of independent observation, experiment, classification, deduction and generalization. These lie at the bottom of all scientific study, all scientific

knowledge. The most profitable science teaching is that which teaches a pupil proper observation and experiment.

When physiology is challenged at the threshold of the high school—what do you bring that we should admit you here?—it must be able to answer and to prove with its kindred sciences that it brings the power of independent thought which is the greatest object to be desired among the masses of the people in present or future time.

Speaking of the moral factor in education at the N. E. A. last summer, President Faunce, of Brown University, said "Over every true school might well be inscribed the sentence which we find in Genesis: 'Let us make man.' Over the entrance to its scientific laboratories may be written: 'Let us help man to make the most of himself.' He who teaches at all follows in the wake of the Creator. He who teaches biology knows that the handful of dust which composes man worked its toil—some way from lowest protozoan to highest mammal, from mammal to man, and through an epitome of race history he must develop afresh the powers of each student.

"With earth's first clay they did the last man knead,
And then of the last harvest sowed the seed,
And the first morning of Creation wrote
What the last dawn of destiny shall read."

Physiology, hygiene and sanitation should, in the mind of the teacher, be the interpretation of the simple physiology of our course of study; for a knowledge of physiology is required in life, far beyond the ground covered by a course of lectures or an elementary textbook.

It is desirable that there be a widespread understanding of the nature of contagious diseases in order that the action of medical boards and boards of health may have a meaning in the minds of the public at large. The creation of such an understanding seems to me an important duty of the public schools.

Some of the most important questions we have to face in our country today arise from ignorance or reckless disregard of the fundamental facts of human existence. The unsanitary condition of the slums, the restriction of disease, the essential facts of contagion and disinfection, the conception of bacteria, infec-

tion and prophylactic measures, the children with neglected eyes and teeth and bodies, social evils and wrongs, from customs contrary to physiological facts—all these must be remedied by the training of young men and women in our laboratories, who shall save society. We can prevent it from becoming the prey of the evil only by producing the wise and good, who shall overcome the evil.

That righteousness tendeth to life, and the wages of sin is death, is not only morality, but physiology. Correct action is dependent upon correct thinking. The more familiar a man is with the laws of nature, the more he will obey them and work in harmony with them, to the benefit of himself and his fellows.

Let me quote once more from President Faunce: "The study of science itself has done much to promote exactness of observation and honesty of report. It has set before us as the model student of the nineteenth century, Charles Darwin, of whom it has been said that in all his voluminous writings not an instance can be found of a fact misstated or consciously perverted. It has given our students patience in study and taught them the greatness of creation."

And as to physiology Huxley said long ago: "There is a very convenient and handy animal which everybody has at hand, and that is himself. * * * Hence the general truths of anatomy and physiology can be taught to young people in a very real fashion by dealing with the broad facts of human structure. * * * So that, in my judgment, the best form of biology for teaching to very young people is elementary human physiology."

PUPIN'S INVENTION.

BY J. W. PATTERSON, JR.

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Much interest has been shown by the scientific world in Professor Pupin's invention of the loaded telephone line, an invention which has vastly improved the transmission of speech over long distances. I may briefly recall the conditions present in the telephone circuit. The line has, sent into it, a certain periodically varying current, called a complex harmonic current. Very little of this current reaches the receiving apparatus at the distant end, in general less than one per cent on long lines; the rest is abstracted by the charging of the line and held back by the line's resistance. If this resistance were absent the charge waves would be transmitted without loss. So the electrostatic capacity of the circuit, in conjunction with the resistance, is an objectionable feature. If it were possible to suppress one or the other, long distance telephony would be possible to any distance. As it appears to be out of the question to suppress either, some counter effect must be sought. Now it is well known that self-inductance combats capacity, and so increased inductance is the most evident remedy. But how to apply it was the puzzle. It was early suggested by some to put self-inductance in parallel with the capacity, but without good effect; others have tried large inductances in series, which also resulted in failure to produce the desired effect. The theoretical problem was so complex that no one before Pupin had solved it. Consequently their experiments did not take the proper form. Professor Pupin first solved the theoretical problem and followed with experiments performed under favorable conditions.

Pupin introduced into the line wire many small equal and equally spaced inductances. The introduction of more self-inductance demands more energy on the line to transmit the same current; but this is no detriment, as the increase of energy hinders the alternation of the current from wave to wave along the line.

*Read before the Physics Conference of the Michigan Schoolmasters' Club, March 28, 1902.

Mathematically a telephone line is like a vibrating cord, and, though reasoning by analogy is exceedingly dangerous, yet it may be very helpful when the mathematical parallelism is close, provided it is checked by experiment. Pupin illustrates the telephone problem by means of the vibrating string. Suppose a very long, light, elastic string, which has no stiffness, to vibrate under the influence of simple harmonic impulses communicated to one end. If the string is long, waves will be produced which, because of air and other friction, have smaller and smaller amplitudes as they run along the cord from the source. With short strings the phenomenon of stationary waves is produced, but in the case considered they are not present to any considerable extent. Had the string more mass in the same cross-section, the damping of the waves would be less. Suppose, as a substitute for more uniformly distributed mass, we load the string at frequent intervals by means of many equal and equally spaced masses, we may approximate the uniformly loaded string. If, however, we apply the whole load at one point or divide it among a few points, we will defeat our object, as the large mass will have a tendency to anchor the string and to reflect the waves and not to transmit them. Thus we may explain the failure of large inductances to improve telephony, when the inductances are localized at a few points. Calling a whole wave length 2π, if the loads are at intervals ϕ, so small that $\sin \frac{1}{2}\phi$ differs little from $\frac{1}{2}\phi$ (say less than 2 per cent), then the wave is well transmitted.

In the telephone circuit we deal with complex harmonic waves which consist of a combination of simple harmonic waves each of the form $i = I\ e^{-bx} \cos(pt - Bx)$ in which i is the current at the distance x from the transmitter at the time t, and I is the maximum current at the origin. The constants b, p and B have to do with the force and velocity of propagation of the wave; the constant b is the attenuation constant and has for its value

$$b = \sqrt{\frac{pc}{2}\left(\sqrt{p^2 L^2 + R^2} - p\ L\right)},$$

in the case of uniformly distributed resistance R, capacity c and inductance L. If L is small in comparison with R this reduces to

$b=\sqrt{\frac{pc}{2}\frac{K}{}}$ (nearly); and if L is large in comparison with R, $b=\frac{K}{2}\sqrt{\frac{c}{L}}$ (nearly). In the former case higher frequency (larger values of p) causes more attenuation; in the latter case the attenuation is independent of the frequency within the limits of the approximation, and large values of L cause reduced attenuation. Both of these properties are favorable to good telephony; for small attenuation means loudness, and uniform attenuation for all frequencies means faithful reproduction of the quality of the voice.

To illustrate the application of the invention we may take a line 250 miles long without the loading coils; suppose L=0, R=9 ohms, C=0.074 m. f. per mile, b=0.000004. This small value of b (0.000004) would make it impossible to hear anything over the line. If to this line we add loading coils having a resistance of 9 ohms extra per mile (in all R=18 ohms) and an inductance of 0.056 henry per mile, we obtain b=0.025, in which case speech will be good.

I understand that the Bell Telephone Co. (Am. Tel. & Tel. Co.), to whom Professor Pupin has sold his invention for a princely sum, is now experimenting on a line 6,000 miles long, obtained by using in series three New York-Chicago lines, which is equivalent to a metallic circuit between cities 3,000 miles apart. The line is said to talk well and it appears quite probable that there will be no difficulty in using a line from New York to the Pacific coast. One big advantage from the commercial standpoint is due to the fact that a New York-Chicago line, which now costs $250,000 for copper alone, may be built with loading coils for less than half that amount. If the saving of capital is as great as expected, the price paid Professor Pupin will prove quite moderate.

ELEMENTS OF AGRICULTURE IN THE HIGH-SCHOOL BOTANY COURSE.

BY RICHARD RUNKE.

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It will no doubt be admitted by all that any change which makes more practical and adds practical value to the botany course is in itself a desirable change. The high-school botany work is too often regarded as a pleasant but quite useless diversion, as a study which may be attractive but of little if any practical value. If such a change as mentioned can be made without detracting in any way from the value of botany as a systematic, disciplinary science the improvement should be welcome. Further than this, if the addition increases the disciplinary value of the study and makes it more valuable the change must be not only desirable but necessary.

Our high-school botany courses always have lacked and do lack direct, practical application. Botany has progressed much in late years. It has moved forward from a theoretical, textbook study to one which requires concrete illustration and application in the laboratory and the field. We should now be ready to proceed still farther and make our laboratory and field work of an intensely useful and practical nature. Of what use are the theoretical, thin-as-air, dry-as-dust conceptions of the textbook? Of little use, unless we apply them. Of what use then, is our laboratory and field work unless we can see its business application, its practical use, its effectual benficial results? Who would think of teaching geography without calling attention to its economic aspect? We no longer teach grammar as a set of dead rules which must be memorized. We apply them and ask for results. In history we demand cause and effect and attempt to deduce rules for future guidance. In botany, therefore, we should strive to give agriculture its true place and thereby modify botany as we have already modified the studies named.

Is it not more than passing strange that many botany courses should ignore the commonest vegetables, fruits, cereals, and trees, and their cultivation and propagation, only to pursue strange gods in stranger places? Has not every pupil a right to demand that

his instruction embrace those things which are abundant in the garden and on the farm? Those things which he meets and sees most often on the farm and in the market? The absence of the elements of agriculture can be accounted for only because of the following reasons: In the first place, our botany teachers are not ready to give the proper instruction because they themselves have received no better nor different training. The second reason embraces the first and gives the real explanation. It is that agriculture has been a despised occupation, one considered much inferior to any other respectable occupation, and inferior to some not respectable. It is generally supposed that any person, no matter how ignorant, can run a farm. That it requires no skill, much less any science, to do so. To be a mere farmer implies contempt instead of implying, as it should, that of all the children of nature the farmer resides closest to his parent. It must be made plain that of all known occupations agriculture requires more real science than any other. The mad rush for city occupations sufficiently attests that agriculture is losing ground in popular opinion. The high-school should do something to stem the tide. It must help to turn the tide the other way.

The demand of every other occupation, profession or trade is reflected in our high-school work. Witness the introduction of bookkeeping, of cooking, of commercial arithmetic, of shorthand, of manual training, of the theory and art of teaching. Does not agriculture, therefore, which is equal in economic importance to all others combined, deserve at least equal recognition? It should certainly receive at least partial recognition in a study where it rightfully belongs, namely botany. Instead of "enriching" the high-school curriculum with work which fails to enrich, let us improve those studies which we have.

Let it not be supposed that this change means a revolution. It means merely that we should modify our courses somewhat. The introduction of the multitude of concrete illustrations and applications which agriculture furnishes will make botany easier to teach, more interesting as a study and less impractical than it now is. Botany will gain in regard by the change, while agriculture will receive no more than just consideraation.

It may be asked by some, "What do you mean by the elements

of agriculture?" It will be seen by the following fragmentary suggestions that no violent change is suggested. Merely a natural unfolding and progress of the study is intended.

Farm losses by parasitic fungi.
Ways in which they injure.
Means of preventing their ravages.
Insect foes and friends of fruits, trees, and vegetables.
Preventatives and remedies. Use and value of spraying.
Work of friendly and unfriendly bacteria.
How to aid the one and destroy the other.
Time and conditions for seeding and planting.
Qualities and grades of seed and selection thereof.
Propagation by cutting, runners, grafts (both stem and root).
Hybrids, varieties, "sports," heredity, environment.
Plant protection in winter, cultivation in summer.
Fodder and its preservation. Silage and silos.
Weeds, kinds, extirpation of.
Soil conditions, plowing, harrowing, tilth in general.
Crop foods, fertility, necessity for rotation.

This list might be extended, but if our high schools will introduce or emphasize the above points a step in the right direction will have been taken.

A "TUMBLER GALVANOMETER."

BY E. C. WOODRUFF.

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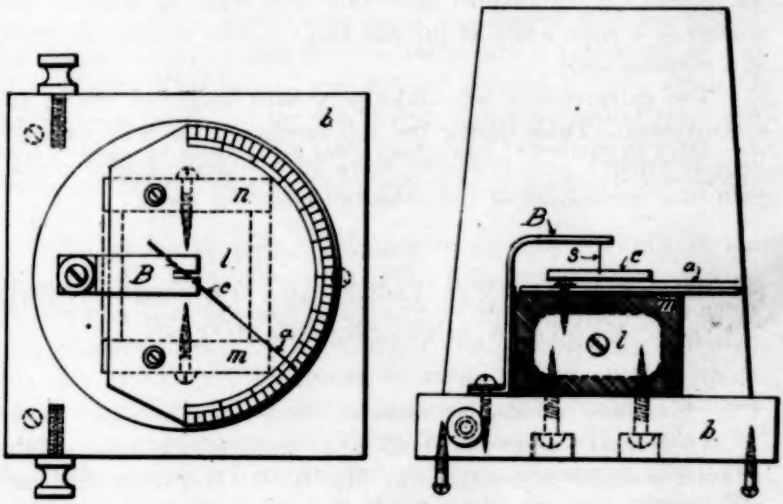
The instrument herein described has competed during the past year with ten other forms of galvanometers in the writer's laboratory. These ten forms, home-made and otherwise, included instruments made after practically all the designs suggested in the different laboratory manuals; besides several more elaborate instruments. Still for high-school laboratory purposes, except for induction and bridge work, they all left some things to be desired. The design here offered grew out of attempts to eliminate these undesirable, and sometimes provoking features. It has proved more generally useful than the others in the following respects: The materials and operations involved in construction and repair are of the simplest. There is the mechanical steadiness of a pivoted compass-needle without its frictional irregularities and tendency

to stick. There is sufficient sensitiveness without the tendency of needles suspended by long fibers to be mechanically disturbed. The details of construction are all in sight so that the pupil grasps them at once. Wide changes in sensitiveness are easily obtained. Magnetic control is very simply arranged. The action of the needle is rapid and the steady deflection can be found quickly, thus saving time for the pupil and energy for the battery. The size is a desirable one, the instrument being covered with a tumbler.

The drawings show a plan and an elevation. The dimensions can be determined from that of the base, 9 cm. x 9 cm. The base *b*,



and the three pieces *l*, *m*, and *n*, that form the frame for the coil, are of hardwood fastened together with brass screws. The coil contains about 100 turns of No. 22 double cotton-covered copper wire, filling the shaded part in Fig. 1. The ends of the wire are brought out through the sides of the frame and then down through the base so as to make connections with the binding posts from below. The wire is sufficiently in sight for the pupil to readily trace the direction of the current through the coil. The cardboard dial is fastened to the sides of the frame *n* and *m*. *B* is of 1-16 inch sheet brass with a saw slit in the upper end so that the suspension can be easily placed to suit. The needle, *c*, has

a length a little less than the width of the coil. This keeps it in a more uniform field. Aluminum wire, *a*, wound around the ends of the needle serves as a counterpoise and a pointer. The suspension, *s*, is made by untwisting a silk thread and separating a strand equal to half a dozen fibers, or less. Though the free length of the fibers is but ½ cm., there is plenty of sensitiveness with a great gain in mechanical steadiness.

For some experiments a shunt is desirable; *e. g.*, such an experiment as connecting batteries in series and in parallel and comparing the deflections with different resistances in circuit. The instrument can be adapted to lecture-table work by bending the pointer at a right angle at the end and bringing it down in front of a suitable scale.

The galvanometer will stand very hard usage for one of its sensitiveness. Twice during the past summer it has been wrapped in a newspaper and sent 300 miles in a heavily loaded trunk, each time coming out of the ordeal all ready for use.

SOME IMPROVEMENTS IN APPARATUS FOR EXPERIMENTS IN ACCELERATED MOTION.

BY E. E. BURNS,

Instructor in Physics and Chemistry, DeKalb (Ill.) High School.

In School Science (Vol. I., p. 202) a new form of the Atwood machine is described by Mr. H. W. Hawkes. This machine appears to me to be the best yet devised for experiments in accelerated motion. Its cost, however, will prevent its immediate adoption in some schools. These schools must be content, for a time, at least, with a simpler form of the experiment. I believe that I have succeeded in eliminating from the inclined plane form of the accelerated motion experiment the sources of error pointed out by Mr. Hawkes. I believe, moreover, that by direct experimental determination of velocity the pupils will obtain a clearer conception of the meaning of velocity than if this quantity is determined by a process of calculation.

Before taking up the experiment in accelerated motion, the pupil has learned that the velocity of a moving body at a given

instant is the distance the body would move during the next unit of time if the rate of motion were to remain unchanged. This will be the condition if, at the given instant, the body starts to move on a horizontal plane where the friction is too small to retard the motion perceptibly. The use of the horizontal plane in this experiment is due to Prof. Snow, of the University of Wisconsin. I have only adapted the experiment to the laboratory.

The inclined track is made by nailing strips of zinc to the sides of a board sixteen feet long and one inch thick, so that the strips project half an inch beyond the edge of the board. The horizontal track is made in the same way, except that one end of the board is beveled and the zinc strips are not fastened at the beveled end. This beveled end is fitted between the zinc strips of the inclined track and the zinc strips of the horizontal track are held in place by means of a table clamp and two strips of wood. A pendulum indicating seconds by means of a telegraph sounder is used.

The error due to the difficulty in starting the ball at the instant of the tick is eliminated in the following manner: A piece of platinum wire fastened to the arm of the telegraph sounder is bent at right angles and dips into a cup of mercury. Through this cup of mercury connection is made with a current which excites an electromagnet at the upper end of the track. A steel sphere one and one-half inches in diameter is held in place by the electromagnet. When the switch of the sounder is closed the first tick breaks the contact at the mercury cup and releases the sphere. To insure the instant release of the sphere a piece of paper should be placed between it and the magnet.

The difficulty of perceiving the coincidence of two dissimilar sensations is obviated by using a second telegraph sounder. This sounder and battery are connected by means of flexible wire cord with a lead push-button which is fastened to a block of wood and held in the groove. I found that this device added greatly to the accuracy of the results, showing that the coincidence of two sensations can be perceived much more accurately when the sensations are similar. The reason for making the push-button of lead is that the circuit remains closed when the ball strikes and only

one tick is heard. By means of a rubber band to deaden the sound the double click of the pendulum sounder is reduced to a single click.

The results obtained with this apparatus are not so accurate as those obtained with the Hawkes-Atwood machine, but they are sufficiently accurate to illustrate the laws of accelerated motion, and, so far as my experience goes, this is more than can be said of the old form of the inclined plane experiment. The following results were obtained by my pupils after the improvements were made in the apparatus:

	d	d	d	v	v
	t = 1.	t = 2.	t = 3.	t = 1.	t = 2.
	29.7	124.6	276.7	64.8	118.4
	29.3	121.9	276.8	58.5	117.0
	30.3	117.0	253.0	61.8	121.5
	31.5	126.6	265.0	65.3	124.1
	31.5	127.9	279.6	65.7	122.2
Means.	30.46	123.6	270.2	63.2	120.6

These results were obtained by ten pupils working in twos, and are all of the results that I have to show, as the improvements were made somewhat late in the year. It will be seen that the velocities which were determined experimentally agree quite well with the theoretical values.

ELEMENTARY EXPERIMENTS IN OBSERVATIONAL ASTRONOMY

BY GEORGE W. MYERS.

(*Concluded from page 228.*)

Experiment XL.

To draw the celestial equator at a given epoch.

This can be best done by means of the spherical blackboard fitted with the precessional circles.

Set the pole pins into the sockets corresponding to the epoch. Then with crayon, or camel's-hair brush moistened with water-color, held against the $O°$ of the meridian and touching the globe,

roll the globe once around. If a number of equators for different epochs are thus drawn, the significance of the precession of the equinox becomes obvious.

Draw the equators for 500 B. C.; 10000 B. C.; and for 5000 A. D.

Experiment XLI.

Find the right ascension and declination of stars for any epoch.

Set the pole pins to the given epoch as before, and bringing the star under the brass meridian, *M*, the declination may be read off directly.

For right ascensions elevate the celestial pole at an angle of 90° to the horizon. The horizon will then indicate the position of the celestial equator for that epoch. Now bring the poles of the ecliptic under the meridian, the north ecliptic pole being south of the north celestial pole. The point on the ecliptic coinciding with the east point of the horizon will then denote the first of Aries for the epoch. By means of the strip, *S*, read off along the horizon the number of degrees from the first of Aries to the brass meridian, *when the star has been brought under this meridian.* Dividing the number of degrees by 15 will give the right ascension in hours, minutes, and seconds.

(a) Find for the epochs 1000 A. D. and 10000 B. C. the right ascensions and declinations of the following stars: Arcturus, Aldebaran, Sirius, Procyon, Canopus.

Experiment XLII.

To find the azimuths of stars at rising or setting for any required epoch.

Set the globe as before and rectify it for the latitude of the place of observation. Then bring the required stars to the eastern or western horizon according as the rising or setting azimuth is wanted. Read off the azimuth along the wooden horizon.

(a) Determine the azimuth at Thebes (Lat. 25° 40′ N.) of the Pleiades, Sirius, and Gamma Draconis and other stars, for 1000 B. C. and 3000 B. C.

(b) Repeat the above measures for the latitude of Chicago (41° 50′).

Experiment XLIII.

To describe an ellipse.

The paths, or orbits as they are called, of all the planets are ellipses, differing not materially from circles. The curve known as the ellipse may be described on paper by tying the two ends of a thread, or string, to pins stuck at the points *S* and *E* the distance between which is less than the length of the thread, and then placing the pencil point at some intermediate point of the thread, keeping both ends taut, slide the pencil along over the paper and the mark produced will be an ellipse.

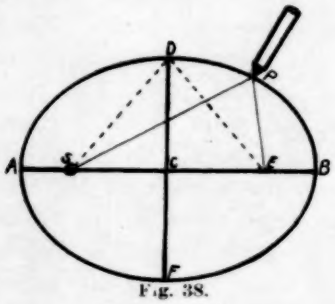


Fig. 38.

The line *AB* drawn through the pin-holes until it touches the curve is called the major axis, and half of it, *AC* or *BC* the semi-major axis, *DF* perpendicular to *AB* at its middle point, *C*, is the minor axis, and half of it, *CF* or *CD*, the semi-minor axis.

Notice that *AB* is the length of the thread, and that when the pencil is at *D*, *SD* and *DE* are equal, and each is equal to half of *AB*.

The semi-major axis is usually denoted by *a*, and the semi-minor by *b*. *SC*, or *CE*, is called the linear eccentricity, and *SC*÷*AC* the eccentricity, and is designated by *c*.

Since *SCD* is the right triangle and SD=*a*, we have—

$$e=\frac{\sqrt{a^2-b^2}}{a};\ SC=ae=\sqrt{a^2-b^2};\ \frac{b^2}{a^2}=1-e^2;\ b^2=a^2(1-e^2)$$

Work out these equations.

The planets with their symbols, orbital eccentricities, and semi-major axes are here tabulated:

PLANET	SYMBOL	ECCENTRICITY e	SEMI-MAJOR AXIS a
Mercury	☿ (Wand)	0.21	36 million miles
Venus	♀ (Mirror)	.01	67 " "
Earth	⊕ (World, with Meridian and Equator)	.02	93 " "
Mars	♂ (Shield and spear)	.09	141 " "
Jupiter	♃ (Old Greek *Z*)	.05	483 " "
Saturn	♄ (Sickle)	.06	886 " "
Uranus	♅ (World)	.05	1782 " "
Neptune	♆ (Trident)	.01	2792 " "

Work out the values of b for each of these orbits.

The semi-major axis of the moon's orbit is 239,000 miles and its orbital eccentricity, e, is 0.055. Find b for the moon's orbit.

Draw ellipses to represent the orbits of the moon, of Mercury and of Mars and note how nearly circles they are.

Note also that the nearer the pins (the foci) are to the center of the ellipses the smaller e is and the nearer the ellipse is a circle.

Metrology.

HOW UNCLE SAM GOT A DECIMAL COINAGE.

BY DR. WILLIAM H. SEAMAN.

(*Concluded from page 236*)

As the colonists imported themselves into the country, so they imported their arithmetics at first, and in Wingate's arithmetic, printed at London in 1735, we have the foundations of weights, measures and money. It would be a good thing if some of this information were retained in the arithmetics of the present day, so that the rising generation would have some idea of the beginnings of things, instead of being left to suppose they always were as they now are.

This little book, a copy of which may be found in the library of the Bureau of Education, tells us that "The smallest weight used in England is the grain, the weight of a grain of wheat, well dried and gathered out of the middle of the ear, of which 32 make another weight called a pennyweight, and 20 pennyweights make one ounce Troy. This was according to the statutes of Henry III., chapter 51, in 1236, and this weight regulated the money of England for about 200 years before the conquest. Osbright, a Saxon, being then king of England, caused an ounce Troy of silver to be divided into 20 pieces called pence. This was the value of an ounce of silver at that time. But in the time of Henry VI. 30 pieces were made from the ounce; Edward IV. made 40, and Henry VIII. increased it to 45, and finally Queen Elizabeth made the ounce into 60 pence, where it now stands. In the same library may be found Pike's arithmetic containing whole pages of tables for converting the various moneys in use in the colonies in 1808 into equivalent values, and also containing the Act of Congress, passed July 6, 1785, establishing the federal currency, according to which the dollar shall contain of fine silver 375.64 grains. In 1786 an act was passed that the mint price of a pound Troy of silver 11-12 fine shall be 9 dollars, 9 dimes and

*Communications for the Department of Metrology should be sent to Rufus P. Williams, Cambridge, Mass.

2 cents. A brief comparison of the tables of monies about a century old in this arithmetic, with the corresponding tables now in use occupying hardly one tenth the space, is one of the strongest possible arguments in favor of the decimal system for all measures.

The earliest coin known to have been made for the British colonies was a brass shilling struck in 1612 by the Virginia company on the Bermuda islands, then known as the Summer islands. The next was the pine tree shilling, authorized by the General Court of Massachusetts in 1652. The mint was built on land of John Hull, who was made mint master. The first coins made were only planchets with the letters N. E. on one side, and XIId, VId, and IIId on the other, only these three denominations being authorized. October 19 a second act was passed, by virtue of which the figure of a pine tree was put on one side in a ring with the words "Massachusetts in," and on the other side the date and value. This coinage was continued till 1686, but it does not appear that the date was ever changed. The office of mint master seems to have been very profitable, and when John Hull's daughter was married the big scales were brought in and the bride put on one pan, while the pine tree shillings were poured into the other till the buxom girl kicked the beam, and thus determined the amount of her dowry.

Both George I and George III had brass and copper coins struck in England for use in the colonies, but no considerable amount ever went into circulation. At the beginning of the Revolution, and down to the adoption of the Federal Constitution, both individuals and the separate states, including Vermont, Massachusetts, New Jersey and Kentucky, exercised the right of making metallic money, but their issues were practically limited to copper cents or half cents. Paper money had been issued by several colonies before the Declaration of Independence, but always based on Spanish milled dollars.

The first Continental Congress met in Philadelphia Sept. 5, 1774, and the second May 10, 1775, but the idea of a national coinage was not suggested in either. The first financial committee was appointed June 3, 1775, to "prepare an estimate of the money required to pay the expenses of Congress." In four days they reported in favor of bills of credit. Several committees

were subsequently appointed with constantly enlarging powers, till in 1776 a Treasury Board was organized with a committee on claims. The latter was soon dispensed with, and the first was found a cumbrous machine, severely criticized by Robert Morris, whose proposition to appoint a regular treasurer was opposed by one Payne, a self constituted watch dog of the people's money, who objected to the increase of officers and the payment of salaries. It was 1779 before the Treasury Department of the United States was fully organized. The principal money the government had was bills of credit, or some form of paper currency, the first supply being in the form of a loan for 6,000 pounds, and the second bills of credit not exceeding 2,000,000 Spanish milled dollars. Thus we see that the pound and the dollar as denominations of money had equal standing at that time. Comparatively little coin was in the country, and most of it of foreign mintage, but several of the colonies had already issued paper money. Many people were impressed at that time, just as they are now, with the facility of this form of making money, and when the question of the best way to meet the expenses of Congress was in debate, one member said: "Do you think, gentlemen, that I will consent to load my constituents with taxes when we can send to our printer and get a wagon load of money, one quire of which will pay for the whole?" In a little more than a year 15,000,000 dollars were authorized, and depreciation began. It does not appear that the word pounds was used after the first loan. One of the issues of paper money provided for small bills of 2-3, 1-3, 1-6, 1-9 of a dollar, so that the first authorized subdivision of the dollar was partially on the binary system. The need of money by Congress was great, and one of the schemes proposed was a lottery. The British government had frequently raised money by lotteries, and in fact some of the money for the subjugation of the colonies was obtained in that way. Congress had as yet no power to raise money by taxation of any kind, and the colonies who had rebelled against Great Britain on the question of taxes were slow to surrender rights they were struggling so hard to gain. The property of loyalists was confiscated and sold, and when, at the discussion as to terms of peace, the

British commissioners proposed restitution, it was refused, first on the ground that it was the act of the several states, and secondly that it was no more than compensation for the private property destroyed by the British, contrary to the laws of war. We have, in fact, in the discussions of those times, precedents for all the questions arising out of the Spanish war. The next expedient of Congress for getting money was the French loan, and here the French denominations had to be considered, and it was to be at the rate of five livres for a dollar. At the end of 1779 200,000,000 dollars of paper money had been issued, and it had become nearly worthless.

In 1781 for the first time, by the articles of Confederation, the states surrendered to Congress the regulation of coinage, weights and measures, making the United States as a whole responsible for bills of credit or loans, in place of individual states. Robert Morris was appointed Superintendent of Finance, and the ineffective and changeable Treasury Board was replaced by a thoroughly competent executive officer. That the denominations of money at this time in use were very numerous we find from a letter of John Adams, who says that "Guineas, half Joes, and Spanish milled dollars are in high estimation, being coin of three different nations." On the 15th of January, 1782, Morris prepared a report on the foreign coins in circulation in the United States, with a plan for American coinage. He had already employed a Mr. Dudley, had had the silver coins in circulation assayed, and had devised plans for machinery to make coin. On April 2, 1783, Mr. Dudley delivered to Mr. Morris the first American silver coin, that is, American in the sense of United States. The preparation of pattern coins was urged forward, and on April 22, several pattern American coins were furnished to lay before Congress. Notwithstanding this beginning, it was ten years before actual coinage was commenced.

The treaty of Paris was signed in 1783 and the United States became an independent nation. In November, 1784, Morris resigned, before any action had been taken by Congress on his report on coinage. This report proposed a very small unit of about 0.07 of a cent, but it also proposed a decimal subdivision.

When Morris resigned Congress appointed a committee to consider the matter of coins and currency and their report was drawn up by Thomas Jefferson. He considered Morris's unit as entirely too small, and proposed the Spanish dollar as "being of convenient size, capable of easy division, and familiar to the people." He agreed with Morris on the matter of decimal subdivision, and said, "The most easy ratio of multiplication and division is that of ten. Every one knows the facility of decimal arithmetic." Acting on this report Congress on July 6, 1785, passed an act defining the money of the United States to be one dollar as a unit, the smallest coin to be copper, 200 to the dollar, the next copper, 100 to the dollar and weighing 2¼ pounds avoirdupois. The dollar shall contain of silver, 11 parts fine, 375 64-100 grains, and there shall be three silver coins besides, a half dollar, a double dime, and a dime; also there shall be two gold coins, one with 246 268-1000 grains of fine gold, equal to ten dollars, to be stamped with the impression of the American eagle and to be called an eagle, and one containing 123 134-1000 grains of fine gold, equal to five dollars, to be stamped in like manner, and to be called a half eagle. Thus the money of the United States was born. In addition to the actual coins the 1-1000 part of a dollar was added as a money of account, to be called a mill. The United States money was thus at first on a purely silver basis, but had a double standard, the value of both gold and silver coins being fixed by law. On the basis of this act a second attempt was made to establish a mint, several dies were procured, a few copper coins, including the Franklin cent, were struck by private contractors, but no regular issue was ever made. It was not until April 15, 1790, that Congress instructed Hamilton, then Secretary of the Treasury, to prepare a plan for the establishment of a United States mint. He brought in his report at the next session, and on March 3, 1791, President Washington affixed his signature to the bill which gave to the United States an actual currency of its own, agreeing substantially with the act passed five years before, and nine years after the treaty of independence. The decimal subdivision of our money we owe to Robert Morris, supported by Thomas Jefferson; the dollar as a

unit of value was simply selected from the great variety of coins current in the United States at the time of the Revolution, as that which was most generally understood and most convenient.

The first silver coins supplied to the Treasury from the Mint were 1758 dollars made from "coins of France" and furnished Oct. 15, 1794. The first gold coins were made from ingots July 31, 1795, 744 half eagles.

America was not the first country to have a decimal currency. China has always had it in small coins, 100 cash to one Mace, and Russia 100 copecks to one rouble, which is sometimes called dolyah, though only 50 cents value.

The dollar, or a coin varying less than 10 per cent in value and of the same name, is now in use in the United States, British America, Mexico, Honduras, Colombia, Equador, Haiti, Liberia, Uruguay, Portugal, Japan (gold yen), and to a considerable extent in China.

France, Spain, Italy, Austria-Hungary, Belgium, Greece, Finland, Switzerland, and Venezuela belong to the Latin Union, in which the franc is the nominal unit, but as the five franc piece approximates in value closely to the dollar, all these countries may be considered as having a uniform coin. This leaves Germany with the mark, Russia with the rouble, and England with the pound as the only aberrant coinages in use by civilized countries, and if an international coin shall ever be adopted, it seems reasonable that it will be the dollar.

Certain it is that no term was ever so widely understood over the whole world as the name of the universal Yankee dollar.

Among the books of information on this subject, Bolles' *Financial History of the United States* occupies the first place, Evans' *History of the Uni'ed States Mint and Coinage* comes next, and other works to be consulted are *The History of Ancient and Modern Coinage*, by Laban Heah Heath & Co., Boston, and *The History of Money in America* by A Del Mar.

NOTES.

Literature on Weights and Measures.—The editor of the Metrology column, while thanking many persons interested in metric reform who have assisted him, would respectfully ask anyone who sees, in the monthly magazines or the daily or weekly press, either long articles or brief notes on the subject of measures or weights, especially metric, to call his attention to them, stating the name of the periodical, with date and page where found, if not convenient to forward the article itself.

La convention du Métre et le Bureau internationale des Poids et Mesures, by Ch. Ed. Guillaume, is a quarto work of 238 pages which contains a very complete account of what has been done by the International Bureau at Breteuil, France. This Bureau was the outcome of the International Metric Convention, which met at Paris in 1870. The work is opportune in view of the new Bureau of Standards at Washington, and of the renewed interest in the metric system in both England and America, and forms a fitting sequel to the classic work of Bigourdan—*Le Systeme Metrique des Poids et Mesures,* issued last year. The work in the well equipped laboratories is described, and illustrated by 88 diagrams. The work on the *Metre des Archives,* to furnish an international standard of length, was very exhaustive. The many discrepancies in determining the weight of a cubic decimeter of water finally led to the adoption of a certain iridio-platinum weight as the kilogram. Much work has been done on thermometry, and on the expansion and contraction of various kinds of glass. With a toluene thermometer a temperature of —74° C. is measured with an accuracy of 0°.05, and there are standard barometers measuring an atmospheric pressure to 0.01 mm. of mercury. There are three kinds of comparators, one for measuring the meter, another for the calibration of tubes, etc., and a third for ascertaining the expansion and contraction of metals. Much original work has been done, as, for example, on nickel steel, which, with 36 per cent nickel, is found to have a very low coefficient of expansion.

In *Cassier's Magazine* for August, E. Sherman Gould criticises the metric system as not being so easy for the field worker or artisan as the units of the English system, though shorter and simpler for the office computer, and he argues that the practical measurer rather than the figurer should be specially favored, basing on this argument an objection to the International System. The inch, foot, yard, fathom and mile, he asserts, are more convenient as measures than the metric units. If this were generally true, it would be a serious objection to the latter system, but it is a sufficient answer that many civil engineers and skilled workmen in various lines after having used both systems prefer the metric. Be-

sides, we have yet to learn that manipulators of measuring instruments in metric countries are less clever than those in non-metric. While allowing that each of the English units can be and is decimalized when desired, the author falls into the common error of assuming that metric units cannot be halved. In view of the marvelous work done on the meridian by Delambre and Mechain, not to mention others, the following statement seems absurd: "The metric system, on the other hand, is the scientifically beautiful conception of a coterie of savants who probably never in their lives had occasion to make a single practical measurement." Mr. Gould regards it a great misfortune that the meter had not been exactly 40 inches instead of 39.37, as in that case the two systems would have been easily interchangeable.

R. P. W.

Notes.

Teachers are requested to send in for publication items in regard to their work, how they have modified this and how they have found a better way of doing that. Such notes cannot but be of great value.

BIOLOGY.

The Marine Biological Laboratory, Woods Holl, Mass., well known to many teachers, has become part of the Carnegie Institution, which will take care of the financial interests. New buildings for permanent laboratories and library, new equipment of boats, etc., are some of the improvements proposed. Its administration and policy are to remain, as heretofore, in the hands of the scientists of the country. Among many teachers the question arises, what will become of the courses in instruction and of those students who have been able to do only small things so far? Professor McKeen Cattell, of Columbia University, in an article in *Science* (September 19), gives the key-note idea on which the Carnegie Institution was founded (in the words of the founder): "To discover the exceptional man in every department of study whenever and wherever found, and enable him to make the work for which he seems specially designed his life work." Then he goes on to say: "We can only find the exceptional man by selecting him from a considerable number who undertake research work. Those who prove themselves incompetent for important original investigations have not wasted their time but are better prepared for teaching or other kinds of work." It

seems probable that the more elementary character of the courses will change to one leading only to research. Yet this has really been the dominant idea all along.

A useful key for the identification of workers of the family Formicidae is given in the September number of the *American Naturalist*, by Dr. W. M. Wheeler, of the University of Texas. Those interested in ant studies will find other papers of Dr. Wheeler's along this line in preceding numbers of the same journal.

The migration of birds, according to C. C. Trowbridge (September number of the *Am. Nat.*), is due to direction and influence of favorable winds, and not temperature, as has been held by other observers.

Teachers who may wish to keep some marine animals inland will be interested in the experiments of Dr. R. True, on *synthetic sea water*. In *Science*, September 12, he tells about keeping algae through the spore stage, jellyfishes, molluscs and fishes, for longer periods of time. Dr. True's experiments at Woods Holl, this last summer, fully justify all that he has said. In some cases the organisms looked better than they did in the normal sea water. The formula will, no doubt, be published later and can then be given to the readers of School Science.

Osmosis; Simple Methods.—Probably the most satisfactory of all is the diffusion cell mentioned in *Ganong's Physiology* (Holt & Co.). The use of an egg for this purpose is so well known as not to need description. It is a little difficult for young students to manage. A simpler form is the half shell of a used egg, from the end of which a few fragments of shell are removed, sugar placed inside, and the whole floated on a dish of "soil water" over night. In this case pupils can see what is going on.

Peabody's Laboratory Physiology recommends sheep's intestine, cleaned, inflated, tied in sausage-shaped segments, and dried. Miss Ellis, Grand Rapids High School, suggests sausage membranes. This might be used in home experiments. The thin membranes between the layers of an onion have been used with varying success. Simpler than this is the method given in Atkinson's "First Studies of Plants," to tie a leaf over the end of a tube, etc.

But simplest of all is the use of a carrot, itself a root, or a potato, given in Macdougal's "The Nature and Work of Plants." Sugar is placed in a hollow made in the carrot or potato and the end cut off so that the bottom may stand in a dish of water one inch deep. A narrow opening, such as might be made with a cork borer, and fitted with a glass tube would show the rise of fluid more easily.

L. M.

GEOLOGY.

A somewhat novel entertainment was given recently by the class in physical geography of the Tama City High School, Iowa, under the title of "Ice and Ice Work." The program consisted of four numbers by members of the class: "The Ice Rivers of the Alps," "The Glaciers of America," "The Frozen Sahara of Greenland," and "The Age of the Great Ice," illustrated by 100 lantern slides loaned by the Department of Geology of Cornell College, Iowa. The program was under the charge of the instructor in science in the high school, Mr. Ralph Williamson.

W. H. NORTON.

Free for the Asking.—By a joint resolution of Congress, the bulletins of the United States Geological Survey, previously sold by the survey, will be distributed gratuitously. The bulletins have been classified in seven series: A, economic geology; B, descriptive geology; C, systematic geology and paleontology; D, petrography and mineralogy; E, chemistry and physics; F, geography; G, miscellaneous.

These bulletins are to some extent technical, but contain a large mass of valuable information for the teacher and student which can now be obtained for the asking. Requests should be forwarded to the Directors of the Geological Survey and should indicate clearly what is wanted, preferably by number. On application to the Director a pamphlet containing a list of all publications of the survey and directions for obtaining them will be furnished.

E. C. C.

CHEMISTRY.

Improved Method of Applying Test for Nitrates.—The usual method of applying the "copperas test" is to mix with sulfuric acid the solution to be tested for nitrates, then to incline the test tube and carefully pour ferrous sulfate solution down the inclined tube in such a way as to have it lie on the surface and expose the brown ring at the junction of the two liquids. The difficulty of successfully doing the last part makes this method awkward. Some years ago I hit upon the following plan, which works admirably: Mix with copperas solution the liquid to be tested, then introduce a thistle tube, running it to the bottom of the test tube, and, with the left hand holding it, together with the test tube, in a vertical position, pour three or four cubic centimeters of sulfuric acid through the thistle tube. In virtue of its superior specific gravity, the acid remains at the bottom, forcing up the other liquid. *If the thistle tube is not disturbed,* the brown ring will at once appear in case a nitrate is present, and much more distinctly than by the usual method.

R. P. W.

The Lime-water Test for Carbon Dioxide.— In testing a gas for carbon dioxide by means of lime-water, two methods are prescribed by manuals generally. One is to conduct the gas into lime-water by a delivery tube; the other is to hold a glass rod, after being dipped in lime-water, in the escaping gas. The former method is often inconvenient, and the latter (the more common one in elementary work) gives much less satisfactory results with beginning students than the reliability of the test warrants. It may, therefore, not be out of place to call attention to a simple method, intermediate to these two, which is quite satisfactory.

A cork of the right size for the test tubes used is fitted with a glass tube of at least 7 mm. internal diameter. By dipping the lower end of the tube into lime-water, a capillary drop can be picked up. The cork is then fitted into the test tube, from which the gas is escaping, just so tightly that the gas slowly bubbles through the drop of lime-water in the end of the tube. The cloudiness becomes very apparent at once, if carbon dioxide is present. It is needless to say that the tube may always be kept in readiness for this purpose.

H. C. Cooper.

To Determine Per Cent of Nitrogen in Air.—Close a large test tube with a tight-fitting, one-hole cork, containing a glass tube drawn out to a fine point and closed there, pointed end outside. Drop into the tube a small piece of phosphorus and replace cork quickly. Ignite the phosphorus by dipping the tube into hot water. Shake the burning phosphorus along the side of the test tube, and, when it has stopped burning, break off the pointed end of the delivery tube under water. The rising water will mark the volume of oxygen consumed. Wait at least five minutes, then indicate the height of the water by a rubber band.

Measure with water the total capacity of tube, allowing for cork. Measure volume of gas left and calculate per cent of nitrogen in air. Results should not vary more than one per cent each way.

To Show that Oxidation Means Increase of Weight.—Protect one scale pan by a piece of metal and place on this a piece of metal gauze, about 3 inches by 1 inch, bent twice at right angles, to form a kind of grate one inch high. Sprinkle on it reduced iron and balance the whole. Heat the iron from below by a taper or Bunsen flame, and watch the pointer of the scale move, decidedly showing increase of weight due to burning. Note change in appearance of product.

Jessie F. Caplin.

Reports of Meetings.

N. E. A. ROUND TABLE CONFERENCE IN PHYSICAL SCIENCE.

MINNEAPOLIS, MINN., JULY 9, 1902.

Mr. W. A. Fiske, Richmond (Ind.) High School, *Leader.*

(*Concluded from page 239*)

Miss Kate Wyman (Faribault, H. S.), Northfield, Minn.: If Mechanics and Heat occupy about half the time devoted to the subject and Electricity the other half, what is to become of the rest of the work? On account of the size of the subject, it would be impossible, perhaps, to omit one of these topics given under Physics.

Mr. P. S. Berg, Science, Larimore, N. D.: I think the leader is correct in stating that half the time should be given to Mechanics and Heat and the other half to the study of Electricity, Sound and Light. We all know that Magnetism does not occupy a very large part of the text book commonly used in the public schools. We further know, upon careful inquiry, that physics is a unit and not an aggregation of many disassociated subjects. When the pupil gets the proper conception of motion, conservation of energy, correlation of energy, electricity and a few other things he has physics; in fact, conservation and correlation of energy are at the basis of the entire subject. Now when the pupil has thoroughly learned Mechanics, has not that pupil the basic knowledge for working out Sound and Light and in good part Electricity?

There are a few things not mentioned in the outline, for instance, the time that physics should be offered. I feel in my experience that it would probably be best if physics were not offered until the last year in the high school. I get from the drift of remarks that were given here this afternoon that a great many problems should be given. I hardly agree with that. No pupil can ever get into real physics unless he is more or less the master of arithmetic, algebra and geometry. So these subjects, I think, should precede physics; and if they do, physics probably ought to come the last year in the high school. How can the pupil ever master specific heat and latent heat and perform the quantitative experiments and solve the problems which underlie them unless he has a well grounded knowledge of algebra? On the other hand, how can the pupil illustrate the principles in connection with Light unless he has some

knowledge of plane geometry? So I hold that after geometry, algebra and a thorough knowledge of arithmetic, physics can be made much more interesting and profitable.

Another thing that has been touched upon this afternoon is the order in which the experimental work, laboratory work and theoretical work and problems should come. This is my order: The theory first—text book work first; after that the experiment to illustrate the theory, after the experiment the problems to illustrate the experiment and the theory, or to strengthen what has been learned before. I hope to hear from others, both upon the time that physics should be offered and what we shall give first. Shall we first give the theory of the subject and then follow that up with experiments and then by problems?

Mr. Barker: Mr. Chairman—I have been requested to speak on the first subject in chemistry—Theoretical Chemistry—when presented, how much, etc. If I were essentially a teacher of physics, I presume I could agree with the last speaker and feel that physics should be given in the senior year, but as my subject is essentially chemistry, I believe chemistry should be given the last year and the entire year. I am perfectly willing that those who wish to give qualitative work the latter part of the year should do so, but for myself, I believe I could give the pupil so much more in theoretical chemistry and the application of it that I have no time to give to the qualitative work.

The approach of the subject by dogma or by experiment, with me has no two answers. I should by all means give the experiment first. I believe we have all passed through the stage when we at one time wanted to be an Indian, at another, a circus rider and so on until we arrive at what we consider to be the highest ground; and so in teaching, especially chemistry, I believe we ought to go at it, to a great extent, in the way it has been—if you wish, in the theoretical way in which chemistry has been developed.

Then the question of the chemical laws. For my own part, I should present first oxygen and when that one subject as an element were thoroughly mastered I would stop and develop a certain number of laws from that; then take hydrogen and the union of oxygen and hydrogen and more laws sandwiched in between. The first half of the year I should not attempt to get any further than the four subjects of oxygen, hydrogen, chlorine and nitrogen, at the same time bringing out almost all the principles of theoretical chemistry. We can utilize in so many ways almost every dogma of our live chemistry. These will present themselves to any teacher and the more practical applications you can get in the better. This is a question that may seem to be a little bit on the danger ground. We are not sure of ourselves when we get in the converse principles of chemistry or any other subject; in fact, whatever the theory may be I always try to distinctly put it as a theory, but I find it very hard work to make the pupils keep theory and law separated. They are always

getting theories as laws—stating them as absolute facts when they are mere theories—and you can say nothing more for them, but at the same time, if the theory is advanced by a man of recognized ability, I believe in bringing it to the notice of a class. If there is anything new on the subject, let the pupil have it; give him the latest and the best, always regarding the point that it may be theory; that there is nothing absolutely certain about it; that the facts can bear out this theory, but that it still is theory, nothing more. Recent theories, I believe, can be presented to a class with a reasonable degree of safety, if there is a reasonable degree of care, but with any theory, let the pupil be in that frame of mind that he can at any time allow that theory be overthrown and a better one take its place, if it shall be advanced, something that satisfies more of the conditions, if there be such a theory; and let the pupil always be ready to tear down the old theory if it doesn't answer all the requirements, and substitute a new one.

MR. FISKE: One of the recent theories that I believe is referred to here is the ionization theory.

In correspondence with some of the teachers of the East, I learn that they do not think very much of that theory and it was stated that the pupils were not able to get much out of it, but in correspondence and conversation with some of the Western teachers, I find that they think a great deal of the ionization theory, especially some of the Chicago teachers, and feel that they see more in it.

MR. TOWER: I want to emphasize that I believe the ionization theory is one that can be presented with a great deal of profit by high-school teachers. I have found it so and thoroughly believe in presenting it. However, that, as well as other theories, I should present at least in the last half of the year, and, better still, the last third, rather than before. It is all right enough to present laws in the first half of the year; I would put those in just as has been stated, but when it comes to theory, I would emphasize that in the last third rather than before. Then you have the facts based upon quantitative experiments, which ought to be included in every high-school course. They can't be such quantitative experiments as we have in the third year of chemistry, but they are sufficiently clear so they can be understood, and it will give that basis for the consideration of theory, which will not otherwise be secured by the pupil; and I thoroughly believe in quantitative experiments as a basis for laws, which, of course, are the basis of theory which we ought to present later in the course.

MR. FISKE: While I believe that physics is distinctly a mathematical subject, yet I further believe that some history should be worked in as well. Physics deals with Boyle's Law and the laws of Newton, and to teach about these laws and not about the men who formulated them, it seems to me something is left out, and in my work I make it a point in taking up these subjects, to have the whole class, or a few members

of the class, or even one member of the class, prepare something definite and to the point, in the way of biography of these men, and if it is possible have their picture before the class, that they may look upon the picture of the person who formulated these laws; and not only these, but any other names that are brought up in the subject of physics. Almost any history of science will give us a great deal of information on these biographical subjects. And I believe it is well to present just as much as we have time to present. This work can be assigned at the time of class and the matter worked out at their leisure.

PRIN. CHAS. A. SMITH: I would like to ask how much time you devote to laboratory work in the week and how much to recitation work?

MR. FISKE: I have five periods a week in physics. I am allowed that much time—five periods a week of 45 minutes each. That is not enough, but three of those periods are spent in the class room and two consecutive periods in the laboratory.

Q: You do not consider that enough?

MR. FISKE: I do not believe five periods a week is enough for a class of juniors in physics.

Q: May I ask you, then, if three periods of recitation and two double periods a week in the laboratory would be sufficient?

MR. FISKE: That would be better, yet I would prefer a little more class room work. If I had seven periods I believe I should take four of them to class room work and three for laboratory work, taking perhaps one period of the four for a special discussion of the work done in the laboratory.

Q: What would you do with the other three days?

MR. FISKE: They might be spent upon recitation and lecture work

Q: Where do problems come in?

MR. FISKE: I do not think it advisable in secondary schools to take a whole period for lecture purposes, but a portion for lecture purposes and the remainder for recitation and problems.

Q: Will you have more problem work with Electricity or Mechanics?

MR. FISKE: I find in my experience that I obtain better results in giving the greater number of problems from Mechanics and Heat, though there is a great field for that kind of work in the subject of Electricity.

Q: Now, come down to one of your questions here in the third division—Physics and Chemistry—Supervision of laboratory work, relation of teacher to pupil during working period.

MR. FISKE: I think the teacher during the working period should be right there with the pupil, at least where he can know positively what the pupil is doing and where he can be at the pupils' command. I do not make it a business, when I am in the laboratory, of passing around from pupil to pupil all the time. It is not necessary to do so. You can tell what they are doing and not be right where they are. If I see somebody

in trouble, who is apparently not doing what he should do, then I am where he is; and if he gets along all right with his experiment and finishes it, he comes to me, and we look it over together, and if it is satisfactorily done it is accepted and he is given another problem; and if it is not, the mistake is pointed out to him and he cheerfully goes back and corrects it—offers to do that, in the majority of cases, without being asked to do so.

Q: Do you give out problems for them to take home and solve, in addition to the laboratory problems?

MR. FISKE: I very often do so.

Q: How many do you take charge of in the laboratory?

MR. FISKE: I think fifteen is a large enough class for anybody in the laboratory. I have had some difficulty in holding it down to that number, but I have been able to do it so far. I won't have more than fifteen in the laboratory unless I have to.

MR. GOODELL: Now, in connection with the laboratory note book. The most important point to me is the time and place of making the record and just how much of a record it should be—whether just the data taken in the laboratory, or the results which are worked out from this data, or still more discussion of the experiment, or whether or not they should have the laboratory note book just one book or whether it should be first an original book or report handed in, and finally a finished book, written in ink and carefully prepared. I know there is a great difference of opinion on that point, which is one well worthy of discussion.

MISS CAPLIN: In chemistry—I speak from my own experience—I was always losing my mimeograph notes and I have tried all kinds of experiments until this last term, when I have been trying an entirely different scheme—making my mimeograph sheets the same size as the note book size and putting down on them the object and processes, and then have them file those with their notes and write out simply the answers to the questions and the conclusions. It seems to me that so much writing is a drudgery and that the time could much better be spent in other ways; and I think I have economized quite a little time in the laboratory by using loose sheets.

MR. TOWER: In physics, during the last two years, I have had the pupils write in ink permanent notes at the time the experiment is performed, and find that while there is perhaps the disadvantage of a thorough review outside of the experiment, in writing it up in permanent form at home, yet there is not only a great saving of time, but also a training in accuracy in putting down in proper form at the time the observations are made the exact results of experiments. So many people have to make two or three trials before getting a thing right, but if we can get our pupils to do it right first, it will be very helpful to them, and I find that making notes in permanent form in the laboratory has brought about this result to a certain extent.

MR. F. F. FARIAR, White Bear, Minn.: If the theory precedes the practice, then, in writing notes under this plan, do you have the theory thoroughly explained before letting the pupil try the experiment, or do you believe in the inductive method to a certain extent?

MR. TOWER: In answering that question, would say that I use no one method for all experiments. It depends also on the experiments. Some require explanation at the beginning and some of them they understand well enough themselves. They need a little help, of course, while doing it, in a certain way, at the time the experiments are done.

MR. FARIAR: Why I asked that question is because I have had difficulty, unless the subject was thoroughly explained, in most cases. Of course, some cases are very simple. It seems to me that if permanent notes are made at the time, they should have the subject quite thoroughly mastered before taking them.

MR. FISKE: The place, it seems to me, to write notes, is in the laboratory, just when the whole matter is red hot. Have the pupil put it down just at that time. I have had a little experience in allowing them to take notes out of the laboratory. They get behind on their notes three or four experiments; and then, more than that, after those notes have (as I have sometimes called it) become cold, they cannot do justice to the experiment. The time to write notes, it seems to me, is at the time the experiment is performed. There is some objection to that, which need not prevent us from having it that way, however, and that is that it takes a little more time. It is hardly just to make a few notes and then write up the experiment afterwards. I would prefer not so many experiments worked and have the pupils finish them right there before they leave them, because I believe better results can be obtained.

I would like to emphasize Miss Caplin's expression as to the saving of time. I use an ordinary note book and divide two pages in the middle, and in the first column at the top write, for instance, "Operation," in the second "Apparatus," in the third, on the next page, "Observation," and in the last, "Conclusion," which is the solution of the problem. That aids me greatly in looking over the notes. It is all finished on these two pages, which may be viewed at one time. What is done is said in one place, and it may be greatly abbreviated, because it is put in a certain place; and what is observed is in another place, and that can be greatly abbreviated; then the solution of the problem has a different place. This plan I have found of very great advantage to me, because so much abbreviation can be carried on.

MR. WM. E. ANDREWS, Taylorville, Ill.: I believe I have detected something of the craft of the college professor here this afternoon, because it seems to me there is a disposition to keep the note book in good form. That is proved in the discussion here, when one says the pupil's work should be well wrought out before he writes it down, if the note book

is to be made permanent at the time. Now, in my opinion, we should pay no attention to the statement in the university catalogues that the pupil's note book will be required. We should not, at least, pay so much attention to that as to lead us to try to get up a fine looking, errorless note book that will be damaging, highly damaging, to the work we need to do; and in my opinion, it would be better to have the pupils write out in the laboratory the work which they have done, to the best of their ability. Then have these notes come in and be carefully examined and errors indicated and record made, of course, if you care to keep a record, and let those leaves, as they have passed through the teacher's hands, with the errors indicated, be the permanent note book of the pupil. The place where the note book is to be prepared should be in the laboratory. There is only one reason under heaven to make a note book, and that is to keep the pupils' minds in the state of thinking and the help the pupil gets from the note-taking he needs to have when he is there with the apparatus, and get answers that the note-taking will cause to arise in his mind. So I think this plan is a good one. Do not try to get a fine looking note book, so that you may be rated high by the college professors, for if you undertake to get a note book that is a creditable looking one you are going to defeat the purpose of the work. Now, I would like to say just a word with reference to that point under 2,—"time given to note book inspection." There is just this thought: You know that the tremendous bore of the science teacher's life is reading the same old stuff year after year, and sheet after sheet, until it is perfectly nauseating. In speaking of the bad place, we think of a place that is very hot, but to my mind the very worst place to put a teacher for eternal punishment would be in a room where there was nothing to read at all but papers, note book papers, and from that kind of punishment, good Lord, deliver us! Dr. Hall has said that if we would stay up more in the day time to prevent errors, we need not stay up so much at night to correct them. Now, the thing that bothers me most in science work is this awful question of being deluged with papers—what to do with them. How can we get the very best effort of the pupil on the papers so as not to have to spend all the very best time of our lives on this work?

Q. Now, if a pupil perform an experiment very smoothly and carefully, and the result is not satisfactory to them ,would that pupil not be required, in such a case, to take the experiment over?

Mr. Andrews: That would appear in the credit which he receives. There is a certain minimum credit which the pupil would have to obtain. It would be wholly termed discredit and it would stand just as a zero would in mathematical work. Now, the benefit is just here—that through being discredited, the fact that they know when they write the first draft that it is upon that the credit is to come, they are very much

more careful in that draft, and they do not pour in upon you every day unmeasured quantities of the same old carelessness and slovenliness as they would if they knew that slovenliness could be done over again and corrected for them.

MR. FISKE: I should like to emphasize that point brought out about saving the teacher's energy and strength and not having so many note books to look over. I do not believe we can afford to do it. I believe we owe it to ourselves and to our pupils to be more than mere machines in this matter. I think if we spend our time in the evenings on anything, and we certainly should, it should not be note books or papers in relation to our school work, but it should be something we can take to our class next day that will give them food for thought and put them on a higher plane than they were the day before. There are teachers who are killing themselves—dragging out their lives looking over notes and papers—and sometimes I feel sorry for them, carrying home whole loads and stacks of papers to be examined that individual night—it must be done before the next morning—and the teacher ought to be free. He can't afford to do these things. Something must be done to economize the time and get the matter in a nutshell, so we will have more time for freedom and thought along different lines than those we are grinding over in the day time. I never take a note book home. I look them over, as I said a moment ago, just as soon as they are done, and then I am through with them.

MR. TOWER: I would like to make a suggestion. As we said in the first place, we would not have enough time and I feel that there are points here that I should like to hear discussed and wonder if it would not be best to have a meeting in the morning. The general program does not interest all, and perhaps we could find out the number that could be here and would like to have such a discussion.

MR. FISKE: We might take the most important points and finish the matter up now. If we could have a meeting, and get it circulated, it might be all right, but it would cause those present some inconvenience to get here again. We are all, no doubt, very much interested in this matter and willing to stay twenty minutes to half an hour longer, but as it is getting late it might be well to adjourn.

The conference adjourned after a two hours' session at 7:00 p. m.